ASSESSMENT OF ODORS AND THEIR CONTROL

ALONG THE CHELSEA WATERFRONT

Prepared for:

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EXECUTIVE SUMMARY

INTRODUCTION

The City of Chelsea experiences odors that, in some cases, are sufficiently strong to cause complaints from local residents. The problem appears to be most acute along the Chelsea Waterfront, where there are multiple potential sources of odor. Some of these are located in Chelsea; other sources may exist in Everett and East Boston. Although the City has been aware of the odor issue and has taken steps to require some sources to implement control measures, odor complaints continue to be received. The situation is complicated by the presence of many industrial operations that emit a variety of odors, making identification of the source of the odors difficult.

In August of 2003, the City retained Bowker & Associates, Inc., an engineering firm specializing in the assessment and control of odors. The scope of the project involved the following tasks:

1. Review available information from City on potential odor sources
2. Conduct inventory of odor sources
3. Conduct neighborhood odor surveys
4. Develop odor mitigation strategy for major sources
5. Prepare odor management plan

An additional task was added that involved sampling of odor emissions from the Global Oil Terminal and assessment of their possible downwind impacts.

INVENTORY OF POTENTIAL ODOR SOURCES

Based on discussions with the City of Chelsea, as well as a series of site visits and odor surveys, the following known or potential odor sources were identified.

Global Oil Terminal

The Global Oil Terminal is located at 11 Broadway in Chelsea and is bounded by the Tobin Bridge on the west, residential/commercial neighborhoods on the north and east, and Chelsea Creek to the south. The site has been used for petroleum storage since the 1930's. The facility as it exists today has been the subject of investigation and negotiation by the City to control emissions of odors during transfer of petroleum products to and from storage tanks located on the site. The Global oil terminal receives primarily No. 2 home heating oil (distillate) and No. 6 bunker oil (residual) by ship or barge. The products are stored and transferred to tanker trucks for distribution.

The truck loading racks are located immediately adjacent to the residential area, with some homes within 100 ft of the rack. Complaints regarding oil fumes have been received from this area as well as from the Admiral's Hill development immediately west of the Tobin Bridge.

Boston Hides & Furs

Boston Hides & Furs, Ltd. is located at 150 Marginal Street in Chelsea. This facility receives mostly cow and calf hides from mid-western U.S. cattle farms. The hides are received "raw," stripped of flesh. At the 150 Marginal Street facility, the hides are trimmed, sorted, and graded. Then the hides are packaged on pallets and shipped, mostly overseas to customers in Europe and Asia. No tanning or other processing of the hides occurs in Chelsea. According to Boston Hides & Furs staff, as many as 100,000 hides are in storage at any one time, awaiting either processing or shipping.

Complaints from local residents have been lodged against Boston Hides & Furs because of the "dead animal"-type odor that is prevalent inside the building and sometimes detectable off-site. The company installed an "odor neutralizer" spray system along the fence near where the hides are received. The material is sprayed at a frequency set by a timer from March through November.

MWRA Wastewater Facilities

The Massachusetts Water Resources Authority (MWRA) operates two wastewater facilities on property near the corner of Marginal Street and the Chelsea St. bridge. One is a wastewater screening and pumping facility that handles local sewage flows. The other is a larger facility referred to as Chelsea Headworks that contains screening and grit removal equipment. The screen house processes about 10 million gallons per day (mgd) of wastewater. The Chelsea Headworks handles an average of 90 mgd, with peaks up to 350 mgd. Both facilities incorporate odor control systems.

Just inside the MWRA fence next to Marginal Street is a junction chamber that is a source of odors detectable by people walking or driving past the property.

Miscellaneous Chelsea Sources

Chelsea Sewer System

There have been several odor complaints related to the presence of ponded water/sewage along Marginal Street between Boston Hides & Furs and Carbone Sheet Metal. During rainstorms, the street becomes flooded and a strong sewage odor has been reported. The storm sewer has a blockage at the outfall structure, and is prone to overflowing during heavy rains. There are several other sewers or catch basins that have been the source of infrequent odor complaints.

Seafood Distribution

There have been occasional complaints of "rotten fish" odors in the vicinity of Winnisimmet St. At the foot of Winnisimmet St. is a small seafood distribution company that receives and ships lobsters. Odors have apparently been related to disposal of dead lobsters in refuse containers outside the building.

General Mills/Pillsbury

Odors of freshly-baked bread are emitted from this large bakery. Although generally regarded as pleasant, there have apparently been some complaints about this odor.

Exposed sediments

Sediments of salt water rivers and marshes can become devoid of oxygen and form odorous compounds such as hydrogen sulfide. The plentiful sulfate in seawater is biologically converted to hydrogen sulfide under anaerobic conditions in the bottom muds. Pollution can exacerbate this situation through the addition of oxygen-demanding organic materials.

Gulf Oil Terminal

Gulf Oil operates a large terminal in Chelsea on Eastern Ave. The facility stores and distributes gasoline, diesel fuel, and light oil such as home heating oil. It is not believed to be a significant contributor to ambient odor levels because it is not close to residential areas and predominant westerly winds convey any odors away from Chelsea.

Diesel Fumes

There is a substantial volume of truck traffic through the City of Chelsea. The sheer volume of trucks passing through Everett and Chelsea makes this a potentially significant source of odors. Exhausts from ships on the Mystic River and Chelsea Creek contribute to such odors.

Non-Chelsea Sources

The areas around Chelsea, including Everett and South Boston, are highly industrialized. The Everett alone, there is an asphalt batching plant, a power plant and liquefied natural gas (LNG) storage facility, and major produce distribution facilities with associated truck traffic. In addition, along the west bank of the Island End River bordering Chelsea is a site contaminated with coal tar that is undergoing remediation.

East Boston is the home of Logan airport. Across Chelsea Creek near the Chelsea St. Bridge is a large tank farm (Conoco-Phillips) that stores jet fuel and gasoline.

SITE VISITS AND ODOR SURVEYS

Multiple site visits were made to facilities in Chelsea that were known sources of odors. The site visits involved tours of the facilities and interviews with staff.

Odor surveys were conducted by Bowker & Associates in the areas potentially affected by odor emissions. Information on location, odor intensity, odor character, and wind speed and direction were recorded. Odors that were detected during these surveys were characterized as “oily,” “sewage,” “fishy,” “dead animal,” “rotten egg,” “fresh bread,” as well as others.

GLOBAL OIL TERMINAL SAMPLING

Global Oil had made a proposal to the City to collect and treat odorous vapors from the residual (No. 6) oil storage tanks and truck racks. The basis for collecting and treating only the No. 6 vapors was that they had significantly higher levels of reduced sulfur compounds such as hydrogen sulfide and therefore had much stronger odors. However, because no odor data were available on the relative strength of the odorous air streams, Bowker & Associates recommended additional sampling and analysis of the Global emissions, followed by odor dispersion modeling to predict the downwind impacts of the various sources.

The analysis of the samples and the odor dispersion modeling indicated that the No. 6 oil storage tanks and truck loading racks account for about 75% of the odor emissions from the facility. However, the modeling predicted that the No. 2 oil truck loading could still result in objectionable odor levels at residences close to the facility.

RECOMMENDED ODOR CONTROL STRATEGIES

Various alternatives to mitigate odor emissions from the major sources of odor were evaluated by Bowker & Associates. Table ES-1 summarizes these recommendations.

CITY-WIDE ODOR ORDINANCE

It is recommended that the City of Chelsea consider a City-wide odor ordinance that would apply to any facility emitting odors. Guidelines for such an ordinance are provided in this report. The City should also consider establishing its own odor hot line. Although Global Oil is required to establish such a hot-line as part of its agreement with the City, there are a multitude of odor sources in and around Chelsea that justify a City-wide hot-line. This could help the City in its efforts to document malodorous conditions and identify the possible sources.

TABLE ES-1

SUMMARY OF RECOMMENDED ODOR MITIGATION STRATEGIES

Odor Source and Location	Type of Odor	Recommended Odor Mitigation Strategy
1. Global Oil Terminal 11 Broadway, Chelsea	Petroleum, sulfur	1. Install capture/treat system for No. 6 and No. 4 tanks and truck racks; measure performance. 2. Continue to monitor and follow-up on complaints from residential areas downwind.
2. Boston Hides & Furs 150 Marginal St, Chelsea	Dead animal	1. Relocate/add odor neutralizer spray to all open bay doors; activate when doors are open. 2. Wash down floors and trucks with bleach or other oxidant daily. 3. Reduce inventory of hides.
3. MWRA Facilities Marginal St at Chelsea Bridge	Sewage, rotten egg	1. Design and construct system to capture and treat emissions from junction box. 2. Conduct annual testing of all odor control systems
4. Chelsea sewer system, Marginal St, Arlington St, others?	Sewage, rotten egg	1. Construct new outfall for Marginal St storm sewer 2. Inventory sewers with regard to odor potential
5. Miscellaneous, City of Everett	Petroleum, rotten egg, others?	1. Meet with City of Everett to identify potential sources 2. Conduct odor surveys to verify major sources. 3. Encourage City of Everett to develop odor mitigation plan.

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1. INTRODUCTION

1.1 Background

The City of Chelsea experiences odors that, in some cases, are sufficiently strong to cause complaints from local residents. The problem appears to be most acute along the Chelsea Waterfront, where there are multiple potential sources of odor. Some of these are located in Chelsea; other sources may exist in Everett and East Boston. Although the City has been aware of the odor issue and has taken steps to require some sources to implement control measures, odor complaints continue to be received. The situation is complicated by the presence of many industrial operations that emit a variety of odors, making identification of the source of the odors difficult.

1.2 Project Scope

In August of 2003, the City retained Bowker & Associates, Inc., an engineering firm specializing in the assessment and control of odors. The scope of the project involved the following tasks:

1. Review available information from City on potential odor sources
2. Conduct inventory of odor sources
3. Conduct neighborhood odor surveys
4. Develop odor mitigation strategy for major sources
5. Prepare odor management plan

In the fall of 2004, an additional task was added that involved sampling of odor emissions from the Global Oil Terminal, and assessing their downwind impacts.

1.3 Approach

Several meetings were held with the Board of Health and the Office of Inspection Services to collect available information. Multiple site visits were made to known sources of odor in order to better understand the operation and identify how and when odors are released. City staff,

councilors, and residents were interviewed. Several odor surveys were conducted by Bowker & Associates in the fall of 2004 to document ambient odors in the Waterfront area and attempt to identify the sources of the odor.

Sampling and characterization of the odor emissions from the Global Oil Terminal was conducted in November, 2004. The collected data were input into an odor dispersion model to predict the downwind impact of the various sources at the facility.

Having identified the major sources of odor, a mitigation plan was outlined for each source. Finally, a review of odor ordinances in other cities was conducted to determine if a City-wide odor ordinance would be an appropriate management tool to mitigate odors in the community.

This report represents the culmination of this work, and provides the following information:

Section 2. Inventory of Potential Odor Sources
Section 3. Results of Site Visits and Odor Surveys
Section 4. Results of Global Oil Terminal Sampling
Section 5. Development of Odor Control Strategies
Section 6. Development of City-Wide Odor Ordinance

2. INVENTORY OF POTENTIAL ODOR SOURCES

2.1 Global Oil Terminal

The Global Oil Terminal is located at 11 Broadway in Chelsea and is bounded by the Tobin Bridge on the west, residential/commercial neighborhoods on the north and east, and Chelsea Creek to the south. The site has been used for petroleum storage since the 1930's. The facility as it exists today has been the subject of investigation and negotiation by the City to control emissions of odors during transfer of petroleum products to and from storage tanks located on the site. The Global oil terminal receives primarily No. 2 home heating oil (distillate) and No. 6 bunker oil (residual) by ship or barge. The products are stored and transferred to tanker trucks for distribution.

Table 1 shows the volume of tankage at the site and the various products stored. The No. 4 oil is a blend of No. 2 and No. 6 oil prepared on-site. Some kerosene is also received, stored, and distributed at the terminal.

Because the No. 6 residual oil is very viscous and does not flow at room temperature, it is heated to approximately 130°F via hot water coils in the tanks. A central boiler burns No. 6 oil for heating the residual oil. Occasionally due to boiler misfires or start-ups, visible emissions of black smoke occur. Such smoke emissions are a concern to local residents. The No. 6 oil is received in three grades based on sulfur content: 0.5% sulfur by weight, 1% sulfur, and 2.2% sulfur. The high sulfur content contributes to the strong odor of this product. By comparison, the distillate (No. 2) contain a maximum of 0.3% sulfur by weight.

Approximately 7 million barrels per year (290 million gal/yr) of petroleum products are received, stored, and distributed at the terminal. Of this volume, about 3 million barrels (130 million gallons) are No. 6 oil.

TABLE 1

TANK CAPACITIES AND PRODUCTS STORED AT GLOBAL TERMINAL(1)

Product	**No. Tanks**	**Capacity, ea.** gal.
No. 2 Fuel Oil	1	5,040,000
	1	4,200,000
	2	840,000
	1	3,000
No. 6 Fuel Oil	1	5,040,000
	1	3,990,000
	1	3,150,000
	2	840,000
	1	1,000
No. 4 Fuel Oil	1	840,000
Kerosene	2	840,000
	1	504,000
Diesel Refuel Tank	1	5,200
Dye	1	4,000
Additive	2	30,000
Slop/Water	1	4,000

There are generally four routes by which odorous vapors are released to the air:

1. During off-loading of ships and barges, displacing odorous vapors in the storage tank headspace.
2. During loading of tanker trucks, displacing odorous vapors in the tank.
3. During normal venting (breathing) of the storage tank.
4. During spills of petroleum products.

The truck loading racks are located immediately adjacent to the residential area, with some homes within 100 ft of the rack. There are 16 truck loading stations of which 10 are dedicated to residual oil (No. 6 or No. 4) and 6 for distillates. Complaints regarding oil vapors have been received from this area (e.g., Front, Medford, Ferry and Beacon Streets) as well as from the Admiral's Hill development immediately west of the Tobin Bridge.

Figure 1 shows the truck loading rack and the residential areas behind it. Figure 2 shows some of the storage tanks.

Another perceived source of odors at the Global Oil Terminal is the boiler used to circulate hot water through the No. 6 oil tanks to maintain temperatures of 130°F or more. The boiler burns No. 6 oil. With any boiler during start-up after maintenance or equipment failure, or during cleaning of heat exchangers, a puff of black smoke is emitted. Such brief releases are considered "normal" in the industry, and occur from power plants and from industrial and commercial boilers. Residents believe that there is a direct correlation of such events with odor episodes. Under normal boiler operation, near-complete combustion occurs, and there is likely very little odor from the boiler stack. Based on discussions with other practitioners in the field, it is unlikely that the release of black smoke (soot) is associated with odor episodes, even though odors may be present at the time these visible emissions are detected. Global utilizes a continuous opacity monitor on the boiler stack. When the opacity reaches a predetermined level, an alarm is activated. A major incident involving soot emissions in 2004 was apparently caused by the accidental closing of an inlet air damper during a routine boiler tune-up. This "choked off" the oil burner, resulting in incomplete combustion and the generation of excessive amounts

FIGURE 1 GLOBAL OIL TERMINAL TRUCK LOADING RACK

FIGURE 2 GLOBAL OIL STORAGE TANKS

of soot. By the time the problem was identified and corrected, a substantial quantity of black smoke had been emitted, the fire department had been called, and local residents were alarmed.

2.2 Boston Hides & Furs

Boston Hides & Furs, Ltd. is located at 150 Marginal Street in Chelsea. This facility receives mostly cow and calf hides from mid-western U.S. cattle farms. The hides are received "raw," stripped of flesh. At the 150 Marginal Street facility, the hides are trimmed, sorted, and graded. Salt is added as a preservative, then the hides are packaged on pallets and shipped, mostly overseas to customers in Europe and Asia.

No tanning or other processing of the hides occurs in Chelsea. According to Boston Hides & Furs staff, as many as 100,000 hides are in storage at any one time, awaiting either processing or shipping.

Complaints from local residents have been lodged against Boston Hides & Furs because of the "dead animal"-type odor that is prevalent inside the building and sometimes detectable off-site. The company installed an "odor counteractant" or "odor neutralizer" spray system along the fence near where the hides are received. The Ecosorb™ system delivers a diluted "neutralizing" agent to a series of nozzles mounted on top of the fence. The "neutralizer" is a blend of essential oils from plants such as eucalyptus, citrus, etc. The theory is that the agent combines with the odorous compounds to render them less odorous. Boston Hides & Furs believes the system is effective, citing lack of odor complaints since the system was installed. However, given that the counteractant solution is sprayed into the air 50 to 100 ft from the source of the odors, it is questionable how much contact actually occurs between the odorants and the counteractant. In the experience of Bowker & Associates, with good mixing and contact, such systems can be expected to reduce the strength of the odor by 20 to 40 percent. As the counteractant has a pleasant odor, it also works as a masking agent, overpowering the foul odor with a pleasant one. The counteractant system is not used during the winter months due to freezing. The material is sprayed at a frequency set by a timer from March through November.

According to Boston Hides & Furs staff, floors are washed down with hot water every night. Similarly, trucks are washed with hot water. No chemicals are used except for occasional use of a pine-scented commercial cleaning product used in the parking and loading areas.

Figure 3 shows a view of the interior of the building with the hides being processed. Figure 4 shows the loading area and the chain-link fence where the odor counteractant spray nozzles are located.

2.3 MWRA Wastewater Facilities

The Massachusetts Water Resources Authority (MWRA) operates two wastewater facilities on property near the corner of Marginal Street and the Chelsea St. bridge. One is a wastewater screening and pumping facility that handles local sewage flows. The other is a larger facility referred to as Chelsea Headworks that contains screening and grit removal equipment. The screen house processes about 10 million gallons per day (mgd) of wastewater. The Chelsea Headworks handles an average of 90 mgd, with peaks up to 350 mgd. Both facilities incorporate odor control systems. The screen house exhausts odorous air to activated carbon adsorbers for treatment. The Chelsea Headworks collects and treats air using packed-bed, wet scrubbers. These systems use a solution of sodium hypochlorite (bleach) and caustic soda to treat the odorous air. When properly operated and maintained, both technologies are very effective for odor treatment, and are used widely in the wastewater industry. Figure 5 shows the screen house with the activated carbon vessels to the far left. Figure 6 shows the Chelsea Headworks with the scrubber exhaust stack.

Just inside the MWRA fence next to Marginal Street is a junction chamber that is a source of odors detectable by people walking or driving past the property. Apparently, an unsuccessful attempt was made to treat the air emitted from the chamber by placing wood chips over the cover.

FIGURE 3 INTERIOR OF BOSTON HIDES & FURS

FIGURE 4 BOSTON HIDES & FURS FENCELINE WHERE THE ODOR COUNTERACTANT SPRAY NOZZLES ARE LOCATED.

FIGURE 5 MWRA SCREEN HOUSE

FIGURE 6 MWRA CHELSEA HEADWORKS

The cover of the junction chamber and its proximity to the Marginal St. sidewalk is shown in Figure 7.

2.4 Miscellaneous Chelsea Sources

2.4.1 Chelsea Sewer System

There have been several odor complaints related to the presence of ponded water/sewage along Marginal Street between Boston Hides & Furs and Carbone Sheet Metal. During rainstorms, the street becomes flooded and a strong sewage odor has been reported. According to MWRA correspondence, the storm sewer has a blockage at the outfall structure, and is prone to overflowing during heavy rains. Figure 8 shows ponded water along Marginal Street as photographed by Chelsea Board of Health staff.

There are other sewers that may be intermittent sources of objectionable odors. There are apparently some illegal sanitary sewer connections into the existing Arlington St. storm sewer that discharges into the Island End River. Unfortunately, there is incomplete information on several storm sewers from Everett that are shown on drawings as "private" sewers.

2.4.2 Seafood Distribution

There have been occasional complaints of "rotten fish" odors in the vicinity of Winnisimmet St. At the foot of Winnisimmet St. is a small seafood distribution company that receives and ships lobsters. Odors have apparently been related to disposal of dead lobsters in refuse containers outside the building. Dead lobsters are now frozen and bagged prior to disposal.

2.4.3 General Mills/Pillsbury

General Mills operates a large bakery at the foot of Admirals Hill next to the marina on the Island End River. Although the "fresh-baked bread" odor is generally regarded as pleasant, there have apparently been some complaints directed at the facility.

FIGURE 7 MWRA JUNCTION CHAMBER AND ITS PROXIMITY TO MARGINAL ST

FIGURE 8 PONDED STORM WATER FROM SEWER BACKUP, MARGINAL ST

2.4.4 Exposed sediments

Sediments of salt water rivers and marshes can become devoid of oxygen and form odorous compounds such as hydrogen sulfide. The plentiful sulfate in seawater is biologically converted to hydrogen sulfide under anaerobic conditions in the bottom muds. Pollution can exacerbate this situation through the addition of oxygen-demanding organic materials. Even in clean salt marshes, the rotten-egg odor of hydrogen sulfide can be quite distinct, particularly in summer months when increasing temperature of water and sediments increases the activities of microorganisms that deplete the oxygen and convert the sulfate to hydrogen sulfide. Figure 9 is a photograph of the exposed sediments of the Island End River between Chelsea and Everett. This is also the point where a large storm sewer discharges that may be contributing to odors.

2.4.5 Gulf Oil Terminal

Gulf Oil operates a large terminal in Chelsea on Eastern Ave. The facility stores and distributes gasoline, diesel fuel, and light oil such as home heating oil. It is not believed to be a significant contributor to ambient odor levels because it is not close to residential areas and predominant westerly winds convey any odors away from Chelsea.

2.4.6 Diesel fumes

There is a substantial volume of truck traffic through the City of Chelsea. The sheer volume of trucks passing through Everett and Chelsea makes this a potentially significant source of odors. Exhausts from ships on the Mystic River and Chelsea Creek contribute to such odors. Jet exhausts from Logan Airport traffic have also been suggested as a possible source, although the relatively high elevation of these emissions promotes good dispersion and dilution.

FIGURE 9 EXPOSED SEDIMENTS OF THE ISLAND END RIVER AT DISCHARGE OF STORM SEWER

2.5 Non-Chelsea Sources

The areas around Chelsea, including Everett and South Boston, are highly industrialized. The Everett alone, there is an asphalt batching plant, a power plant and liquefied natural gas (LNG) storage facility, and major produce distribution facilities with associated truck traffic. In addition, along the west bank of the Island End River bordering Chelsea is a site contaminated with coal tar that is undergoing remediation. Figure 10 shows some of the heavy industry along the Everett waterfront. Figure 11 shows the floating boom placed around the coal tar contamination site.

East Boston is the home of Logan airport. Across Chelsea Creek near the Chelsea St. Bridge is a large tank farm (Conoco-Phillips) that stores jet fuel and gasoline.

2.6 Summary of Potential Odor Sources Near the Chelsea Waterfront

Figure 12 shows an aerial photograph (1995) of the Chelsea area, identifying potential sources of odor that may be detected by residents living near the Chelsea waterfront.

FIGURE 10 HEAVY INDUSTRY ALONG THE EVERETT WATERFRONT

FIGURE 11 COAL TAR CONTAMINATION SITE IN EVERETT

FIGURE 12 POTENTIAL ODOR SOURCES NEAR THE CHELSEA WATERFRONT

3. RESULTS OF SITE VISITS AND ODOR SURVEYS

3.1 Site Visits

Site visits were made to several facilities in Chelsea that were known sources of odor. The site visits involved tours of the facilities and interviews with staff. In addition to the specific facility visits, Bowker & Associates was provided at least three tours of the Waterfront area and potential odor sources by City staff.

3.1.1 Global Oil Terminal

Robert Bowker and Joe Cooney of the City's Inspectional Services Division were provided a tour of the Global Oil Terminal by Global staff on August 25, 2004. Ron Kenney and Jamie Cook of Global were also interviewed regarding the operation of the terminal. At the time of the site visits, some petroleum odors were noticeable around the truck loading rack and occasionally while walking between the storage tanks. As described in Section 4 of the report, Bowker & Associates was back at the terminal on November 15, 2004 to sample the emissions from the storage tank vents and truck racks.

3.1.2 Boston Hides & Furs

Mr. Bowker toured Boston Hides & Furs with a representative of the City's Inspectional Services Division on August 25, 2004. Follow-up visits were made on November 16, 2004 and March 29, 2005. During the August visit, some odors were noted in the parking lot/unloading area on the east side of the building. Inside the facility odors were of moderate intensity with a "dead animal" character. Generally, hides were stacked on pallets except in the processing room where the hides were being trimmed and sorted.

During the second visit in November, no odors were detected outside the building. Moderate odors were detected inside the facility. Because of recent complaints regarding sewage odors along Marginal Street, several drains were inspected. As shown in Figure 13, standing water was

FIGURE 13 DRAINAGE PROBLEM AT BOSTON HIDES & FURS UNLOADING DOCK

observed in the truck unloading area due to inability to drain by gravity into the storm sewer. According to Boston Hides & Fur staff, a pump must be used to remove accumulated water. It is not known if a blockage exists in the service lateral, or if the water elevation in the street sewer prevented drainage of water from the truck loading area. When the storm drain in the street in front of Boston Hides & Furs was inspected, the water elevation was within several inches of the street elevation, indicating a surcharged condition.

3.1.3 MWRA

Two site visits were made to the MWRA facilities on August 25 and November 15, 2004. Both the screening/pumping facility and the Chelsea Headworks were inspected. On the days of the site visits, moderate odors were noted around the junction chamber adjacent to Marginal Street. Little or no odor was detected around the buildings housing the wastewater processing equipment. The wet scrubber treating odorous air from the Chelsea Headworks appeared to be operating satisfactorily, with scrubber operating parameters (pH and oxidation-reduction potential) in the appropriate range. MWRA staff monitors the air pressure in the wastewater processing area to confirm that it is maintained under a slightly negative pressure. This ensures that the odorous air is captured by the ventilation system and is conveyed to the wet scrubber.

3.2 Odor Surveys

A series of neighborhood odor surveys were conducted by Bowker & Associates along Marginal Street, Broadway, and the Admiral's Hill area. These surveys were conducted by either walking or driving slowly through areas potentially impacted by odors. When an odor was detected, several parameters were recorded, including:

- location
- odor intensity (0 to 5 scale)
- odor character
- wind speed and direction
- temperature

Odor intensity is a measure of the strength of an odor. For ambient odor surveys, a 0 – 5 scale is often used, with the intensity of the ambient odor referenced to a series of odor "standards" comprised of ascending concentrations of n-butanol in water as described in ASTM E-544. In lay terms, the scale is as follows:

0 – no odor
1 – very faint
2 – faint
3 – noticeable or distinct
4 – strong
5 – very strong

The character of an odor is a description in response to the question, "What does it smell like?"

Odor surveys were conducted on the morning of August 25, in the evening of August 25, during the morning of August 26, on September 3, and in the evening of October 5.

Note that a limited number of surveys were conducted. Although odors were sometimes detected during the course of the surveys, it is often difficult to assess the severity of the odors during such activities. This is because odors are typically transient, traveling in "puffs" which are at the mercy of the wind and which may only last a few minutes. In some cases, odors downwind of a source may be readily apparent at one location, but not detectable 100 ft away. Therefore, during the conduct of odor surveys, it is difficult to be "at the right place at the right time" when odors may be intense. To collect meaningful data by which to assess the significance of a particular source, it is necessary to make many observations over a period of weeks or months, which was beyond the scope of this project.

Table 2 summarizes the results of the odor surveys. During the August 24 survey, "rotten fish" odors were detected at the base of Winnisimmet St. These odors were apparently emitted from a refuse container. Very faint sewage odors were detected downwind of the MWRA facilities, and fleeting "oily" odors were detected in the Admiral's Hill area. In the neighborhood behind Boston Hides & Furs, odors were characterized as "dead animal," "ammonia," and "sweet." The

TABLE 2

RESULTS OF AMBIENT ODOR SURVEYS
Chelsea, MA

Date	Time	Location	----- Odor -----		----- Wind -----		Temperature °F
			Intensity (0 – 5)	Character	Speed	Direction	
8/25/04	3:50 PM	Bottom of Winnisimmet	2-3	Rotten, fishy	2-8	ESE	82
	4:25 PM	Corner of Willow & Maverick downwind of MWRA	1	Sewage odor	3-5	ESE	74
	4:45 PM	Admiral's Hill at Hospital Park	1	Oily	3-8	ESE	80
	7:45 PM	Admiral's Hill at Hospital Park	1	Oily	3-5	SE	68
	7:50 PM	Admiral's Hill; 500 ft downwind of Chelsea Sandwich oil terminal	1-2	Oily	3-5	SE	68
	8:00 PM	Corner of Shawmut and Suffolk behind Boston Hides & Furs	2-3	Dead animal, ammonia, sweet	2-4	SE	67
8/26/04	6:15 AM	Admiral's Hill at Hospital Park	0	no odor	calm	–	58
	6:25 AM	Bottom of Winnisimmet	1	Oily	0-1	W	57
	6:40 AM	Highland and Suffolk	1	Musty, dead animal	1-2	W	58
	6:50 AM	Marginal St in front of MWRA	3	Sewage	1-3	W	58
9/3/04	11:30 AM	Harbor Master boat along Island End River; east shore	1-2	Rotten egg	5-10	SW	80
10/5/04	8:45 PM	Admiral's Hill area	0	no odor	0-2	NW	52
	8:50 PM	Broadway and Beacon	2-3	Garlic	2	NW	52
	8:50 PM	Marginal St near salt pile	1	Faint sewage odor	calm	NW	52
	9:00 PM	Behind Boston Hides & Furs	1-2	Dead animal	0-2	NW	52
	9:10 PM	Marginal St in front of MWRA	3	Sewage	calm	–	50
3/29/05	3:00 PM	Admirals Hill nr marina	3	Fresh bread, bakery	5-10	W	?

sweet odor was associated with the odor neutralizer that was being sprayed into the air. Despite the presence of the odor neutralizer, the underlying "dead animal" odor was still detectable.

Similar odors were detectable on the morning of August 26 in the proximity of the odor sources, including Global Oil terminal, MWRA, and Boston Hides & Furs. The "sewage" odor was quite distinct on Marginal St in front of the Chelsea headworks. The source was likely the junction chamber that apparently vents odorous air.

On September 3, Mr. Bowker accompanied Councilor Ron Morgese and William Murphy, Harbormaster, on a boat tour of the Island End and Mystic Rivers along the Chelsea waterfront. Between 11:30 am and noon, relatively faint "rotten egg" odors were detected along the east shore of the Island End River not far from the marina. Winds were from the west, generally from the direction of Everett. Despite attempts to located the source of this odor, it could not be identified.

Another series of surveys were conducted on the evening of October 5. Some "sewage" odors were detected in front of MWRA, and near the salt pile on Marginal St. "Dead animal" odors were detected behind Boston Hides & Furs. "Garlic" odors were detected at the corner of Broadway and Beacon, most likely from a sandwich shop at that intersection. No "oil" odors were detected during the October 5 survey.

On March 29, 2005, while conducting an inspection of potential odor sources around the Island End River, Bowker & Associates detected moderately strong odors of freshly baked bread in the Admirals Hill area across from General Mills/Pillsbury. Winds were from the west at 5 to 10 mph. The source of this odor was the cooking ovens at General Mills.

4. RESULTS OF GLOBAL OIL TERMINAL SAMPLING

4.1 Introduction

Global Oil had made a proposal to the City to collect and treat odorous vapors from the residual (No. 6) oil storage tanks and truck racks. The basis for collecting only the No. 6 vapors was that they had significantly higher levels of reduced sulfur compounds such as hydrogen sulfide and therefore had much stronger odors. However, because no odor data were available on the relative strength of the odorous air streams, Bowker & Associates recommended additional sampling and analysis of the Global emissions, followed by odor dispersion modeling to predict the downwind impacts of the various sources. The City agreed and directed Bowker & Associates to perform the testing.

4.2 Methodology

Split samples were collected in Tedlar bags using a vacuum chamber and Teflon tubing. Vacuum was induced using an SKC sampling pump. Samples were collected from the following locations:

Sample No.	Location
1	Truck manhole during filling w/No. 6 oil (1% sulfur)
2	Truck manhole during filling w/No. 6 oil (0.5% sulfur)
3	Truck manhole during top loading w/ No. 2 oil
4	Truck manhole during bottom loading w/No. 2 oil
5	Tank vent during transfer of No. 6 oil (1% sulfur)
6	Tank vent during transfer of No. 2 oil
7	Tank vent during transfer of No. 2 oil
8	Tank headspace No. 6 oil (0.5% sulfur)

One sample from each location was sent via overnight carrier to St. Croix Sensory in Lake Elmo, MN for odor panel testing in accordance with ASTM E-679. This test measures the odor strength by the number of dilutions of odor-free air required before half of an 8-person odor panel can no longer detect the odor.

One sample from each location was sent via overnight carrier to Columbia Analytical in Simi Valley, CA for quantification of reduced sulfur compounds in accordance with ASTM-5504 (GC-SCD).

4.3 Analytical Results

Table 3 summarizes the analytical results from the sampling program. Observations from the data are as follows:

1. The odor "concentration" data are highly variable, and there is a poor correlation between the reported odor concentration and the levels of reduced sulfur compounds.
2. Generally, odor concentration of the headspace of No. 6 oil was 3 to 7 times higher than the headspace of No. 2 oil.
3. Levels of hydrogen sulfide in the No. 6 oil headspace were significantly lower than found in previous testing by Global. When questioned, the laboratory confirmed the low H_2S levels.
4. Considering all samples, average odor concentration of the No. 6 oil headspace was 9,350 dilutions to threshold (D/T) and average odor concentration of the No. 2 oil headspace was 3,875 D/T.
5. Neglecting sample #5 as being non-representative due to tank conditions (unheated, nearly empty tank) and sample # 6 as an "outlier," average odor values were as follows:

   No. 6 oil headspace – 11,100 D/T

   No. 2 oil headspace – 2,833 D/T

4.4 Dispersion Modeling

4.4.1 Description of Model

Dispersion modeling was accomplished using Trinity Consultants Inc. SCREEN3 model. SCREEN3 is based on the U.S. EPA Industrial Source Complex-Short Term (ISCST) model and

TABLE 3

SUMMARY OF ODOR PANEL AND REDUCED SULFUR DATA
GLOBAL-CHELSEA OIL TERMINAL
November 16, 2004

Sample No.	Time	Location	Odor Conc'n[1] D/T	Reduced Sulfur Compounds,[2] ppb																		
				H_2S	CS	MM	EM	DMS	CS_2	IPM	t-BM	n-PM	EMS	Th	IBM	DES	n-BM	DMDS	3-MTh	THTh	2,3-DETh	2-Eth	DES_2
1	10:00 AM	Vent MH from truck loading No. 6 oil – (1% sulfur)	4,300	36.7	29.1	2,600	624	22.0	156	662	1,130	206	15.1	917	95.3	ND	50.7	35.9	414	111	189	182	6.39
2	10:20 AM	Vent MH from truck loading No. 6 oil – (0.5% sulfur)	18,000	61.2	34.8	155	316	32.8	158	300	1,400	165	20.8	450	122	8.10	40.9	9.44	205	53.4	106	101	7.01
3	10:50 AM	Vent MH from truck top – loading No. 2 oil	2,500	1,310	15.4	7.31	6.66	ND	ND	ND	9.17	ND	ND	16.2	ND	ND	ND	ND	21.1	6.02	12.0	15.8	ND
4	11:10 AM	Vent MH from truck bottom – loading No. 2 oil	2,500	382	10.7	ND	5.08	ND	ND	ND	ND	ND	ND	15.5	ND	ND	ND	ND	20.3	ND	10.8	12.9	ND
5	11:45 AM	Tank #104 vent during transfer of No. 6 (1%) oil (tank nearly empty)	4,100	8.20	19.7	54.3	24.1	ND	7.39	15.8	15.6	7.94	ND	78.0	ND	ND	ND	10.8	66.8	11.9	28.7	32.5	ND
6	12:15 PM	Tank #108 vent during transfer of No. 2 oil	7,000	ND	23.8	ND	5.29	ND	ND	7.63	ND	ND	ND	22.1	ND	ND	ND	ND	18.6	7.12	7.00	11.1	ND
7	12:30 PM	Tank #108 vent during transfer of No. 2 oil	3,500	80.5	43.9	35.3	41.0	ND	3.70	8.30	43.2	7.67	ND	26.2	ND	13.0	ND	39.5	23.2	5.55	8.93	11.7	37.0
8	12:40 PM	Tank #202 vent – No. 6 (0.5%) oil; tank 1/5 full (no transfer)	11,000	55.2	25.9	101	254	29.6	160	265	1,300	143	17.8	461	126	9.04	41.4	11.2	233	60.2	115	122	9.11

1 The number of times the sample must be diluted with odor-free air until it is no longer detectable by 50% of the odor panelists.

2

H_2S	hydrogen sulfide	CS	carbonyl sulfide	MM	methyl mercaptan	EM	ethyl mercaptan
DMS	dimethyl sulfide	CS_2	carbon disulfide	IPM	isopropyl mercaptan	t-BM	tert-butyl mercaptan
n-PM	n-propyl mercaptan	EMS	ethyl methyl sulfide	Th	thiophene	IBM	isobutyl mercaptan
DES	diethyl sulfide	n-BM	n-butyl mercaptan	DMDS	dimethyl disulfide	3-MTh	3-methylthiophene
THTh	tetrahydrothiophene	2,5DMTh	2,5 dimethylthiophene	2-Eth	2-ethylthiophene	DES_2	diethyl disulfide

ND = not detected

is designed to perform a screening-level estimate of downwind pollutant concentrations. SCREEN3 predicts conservative or worst-case estimates of maximum short-term air quality impacts from specific pollutant sources. Modeling is performed within a matrix of 54 variable combinations of wind speed (1–20 m/s) and atmospheric stability class (A–F). Each stability class is based on static stability (related to the change in temperature with height), thermal turbulence (caused by heating of the air at ground level), and mechanical turbulence (a function of wind speed and surface roughness). Using calculated odor emission rates (the product of odor concentration and air flowrate), modeling of individual sources of odor was conducted to produce a worst-case estimate of predicted odor concentrations at the nearest receptors.

The following sources of odor were modeled:

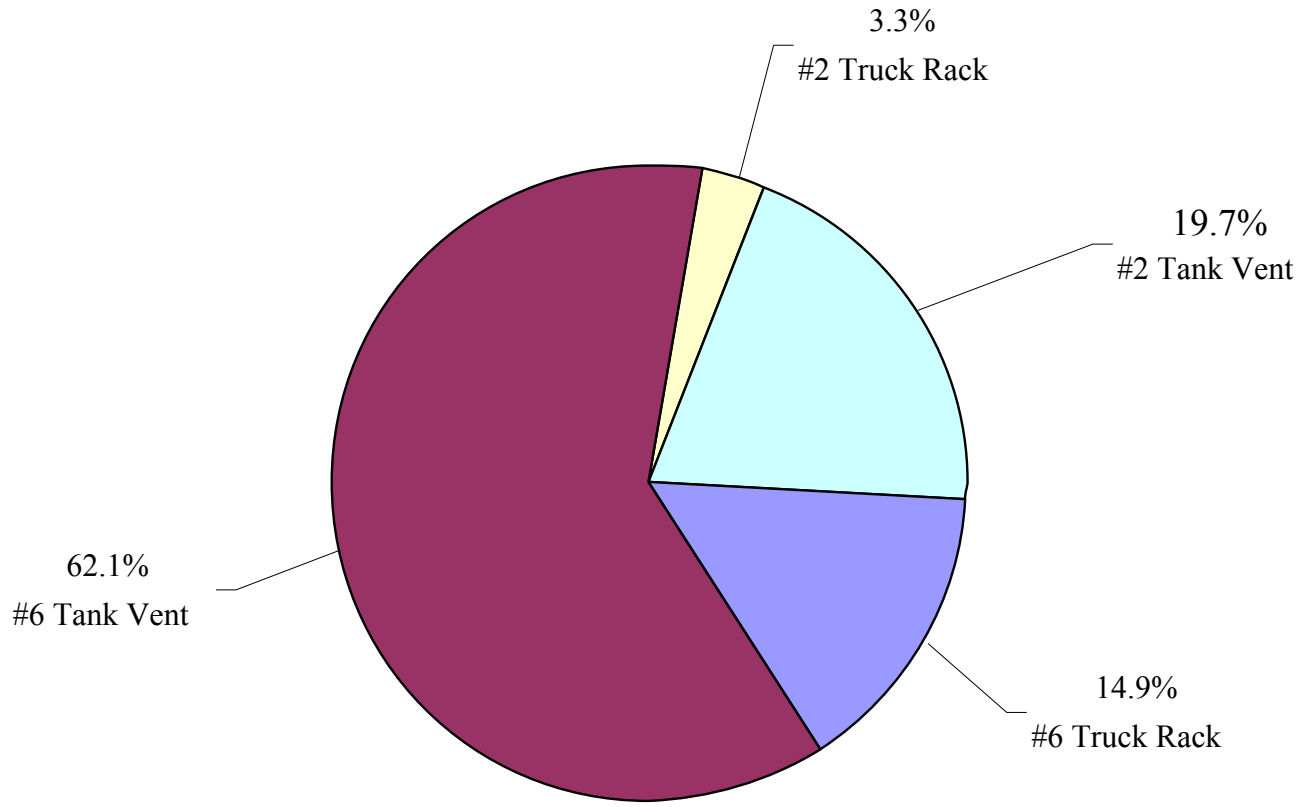
- 3 trucks simultaneously loading #6 oil @ 550 gal/min each
- 3 trucks simultaneously loading #2 oil @ 550 gal/min each
- ship off-loading #6 oil to storage tank @ 10,000 bbl/hr
- ship off-loading #2 oil to storage tank @ 10,000 bbl/hr

The distances from the odor source to the nearest receptor was assumed to be 100 to 330 ft (30 to 100 meters).

Because odors are often transient and occur for short durations, the results were converted to 3 minute peak values using a power law function reported in the literature. A peak-to-mean conversion factor of 5 was used.

4.4.2 Results

"Odor emission rate" is the product of odor concentration and air flowrate, and is analogous to a mass emission of pollutants. Odor emission rate is a critical input parameter for the dispersion model. Figure 14 shows the contribution of the major sources to the "total" odor emissions, given the assumptions listed. This graphic shows that the No. 6 facilities, including both the tank vents and the truck racks, account for about 77% of the total emissions, with the No. 2 facilities accounting for about 23%. It also shows that when a ship is off-loading No. 6 oil, this alone



Assumptions:
1. Three trucks loading #2 oil @ 550 gpm ea.
2. Three trucks loading #6 oil @ 550 gpm ea.
3. Storage tank filling with #2 oil @ 10,000 bbl/hr
4. Storage tank filling with #6 oil @ 10,000 bbl/hr

FIGURE 14 MAJOR SOURCES OF ODOR EMISSIONS FROM GLOBAL-CHELSEA TERMINAL

accounts for over 60% of the total emissions. In reality, the percentage would be far greater since two ships would never be off-loading No. 2 and No. 6 oil simultaneously.

Of greater significance is the predicted impact of these various emissions on downwind odor levels. Table 4 summarizes the results of the dispersion modeling, showing the predicted impacts at 100 ft downwind and 330 ft downwind. The downwind odor impacts from the No. 6 oil facilities are predicted to be three to four times those of the No. 2 facilities. For example, at 100 ft downwind of the truck rack, peak odor levels are predicted to be 83 D/T from three trucks simultaneously loading No. 6 oil, while peak odor levels at 100 ft are predicted to be 23 D/T from three trucks simultaneously loading No. 2 oil. At 330 ft downwind, predicted impacts from the truck rack are 14 D/T from the No. 6 oil trucks and about 5 D/T from the No. 2 oil trucks.

The downwind odor impacts from the filling of an oil tank at the maximum rate of 10,000 bbl/hr are predicted to be similar to that of the truck rack. The oil tanks were modeled assuming that the odors are "downwashed" due to the effect of the large storage vessel on wind patterns. The predicted attenuation of the odors between 100 ft and 330 ft is relatively low with the tank emissions compared to those of the truck rack. This may be due to the effect of "downwash" that sweeps odors off the tank vents down to ground level.

In many cases where odor emissions are modeled to predict their downwind impact, an acceptable "target" ambient odor level is selected. Historically, this target odor level has been 5 to 7 D/T. This would be considered a very faint odor that would be unlikely to elicit an odor complaint. With recent changes in the rate that the olfactometer presents the diluted sample to the panelists during odor testing, higher odor numbers have been reported, and there has been some suggestion that the "target" ambient odor levels should be adjusted upward. In a recent project in Calgary, target odor concentrations of 25 D/T were selected for the property line, and 10 D/T at the nearest receptor (15 minute averages).

The modeling indicates that although the No. 6 oil facilities have a significantly greater impact on downwind odor levels than the No. 2 oil facilities, the No. 2 oil truck rack is still predicted to exceed a target value of 10 D/T at the nearest receptor (100 ft) under worst-case meteorological

TABLE 4

RESULTS OF SCREENING LEVEL DISPERSION MODELING
Global-Chelsea Terminal Odor Emissions
Chelsea, MA

Source	Source Odor Conc'n D/T	Air Flow cfm	Predicted Downwind Odor Level			
			-- 30 m (100 ft) --		-- 100 m (330 ft) --	
			Avg. 1-hr D/T	Peak 3-min. D/T	Avg. 1-hr D/T	Peak 3-min. D/T
Truck rack (3 trucks) #2 oil	2,500	221[1]	5.1	25	0.95	4.8
Truck rack (3 trucks) #6 oil	11,150	221[1]	16.7	83	2.5	14
Tank vent #2 oil	3,500	936[2]	3.2	16	2.1	11
Tank vent #6 oil	11,000	936[2]	9.9	50	5.7	29

Typical target odor at receptor: <5 to 7 D/T

1 Based on truck fill rate of 550 gpm per truck
2 Based on maximum tank fill rate of 10,000 bbl/hr (700 gpm); off-load from ship

conditions. The No. 2 oil tanks are further from any receptors than the truck rack, and are less of a concern (predicted peak odor concentration of 11 D/T at 330 ft). In contrast, the No. 6 oil tanks are predicted to result in peak odor levels of 29 D/T at 330 ft away.

5. DEVELOPMENT OF ODOR CONTROL STRATEGIES

5.1 Global Oil Terminal

In 2004, Global Petroleum Corporation proposed to install a system to capture and treat the odorous vapors from the residual oil (No. 6 and No. 4) storage tanks and truck loading racks. The vapors from the No. 2 tanks and truck racks would not be collected based on previous experience of the equipment vendor and sampling data that showed that the most intense odors were associated with the reduced sulfur compounds present at much higher concentrations in the No. 6 vapors. The system included the following elements as proposed by Applied Contaminant Control (ACC) in Edmonton, Alberta (2):

Stage 1 – Vapor Capture System

The first stage of the system is vapor capture. At the tanks, a tank vent hood specifically designed to capture vapors at the vent is employed. At the truck loading stations, a flexible hose is used to capture vapors from the truck manhole.

ACC's tank vent hood is a proven design that offers several significant operational advantages. It provides near 100% fugitive vapor capture, does not subject the vapor space to any negative pressure, prevents rain from entering the tank, and helps prevent condensed product from draining onto the top of the tank.

The tank vent hood allows the tank to vent as if it was not connected to an exhaust system. This eliminates the unnecessary additional liquid and gas loading on the system that would otherwise be caused by tank headspace vacuum. In addition, the tank is free to vent to atmosphere if the exhaust system is shut down for maintenance.

Once captured, the vapors, which consist of liquid and gaseous contaminants, are transported through a ductwork system to the odor abatement equipment.

Stage 2 – Mist Elimination System

The second stage of the system is a mist elimination system which provides liquid aerosol filtration to a minimum separation efficiency of 99% on particles less than 3 microns, or to a maximum outlet loading of 0.2 mg of liquid per actual cubic foot of gas.

The mist elimination system design has evolved from many years of asphalt and oil aerosol filtration experience. The system employs two successive stages of filtration, each of which plays an important role in the operation of the collector.

The 1st stage is a pre-filter designed to remove ambient dust and dirt and any other particulate matter that finds its way into the exhaust system. Prefiltration is essential to extending the operating life of the second stage filter.

The second stage uses high efficiency Monsanto fiber bed mist eliminators. These filters utilize several mechanisms to provide the highest liquid aerosol separation efficiency available for this application. This is essential for the protection of the gas filtration media downstream in the odor control system.

An integral liquid sump stores collected liquid. The liquid is drained from the vessel at a frequency dependant upon the system liquid load. Pressure gauges are included across each stage of filtration, as well as at the inlet to indicate inlet pipe vacuum. In addition, a local gas temperature gauge has been included.

Stage 3 – Odor Treatment System

This stage is a deep bed dry scrubbing system that will reduce the gas stream H_2S concentration to a level acceptable for atmospheric dispersion.

The ACC Deep Bed Gas Filter specifically targets the removal of reduced sulfur compounds. The primary compound of concern for odor control purposes is H_2S.

The media employed is a dry chemical consisting of a powerful oxidant, potassium permanganate, which has been impregnated onto a zeolite substrate. Permanganate has been employed for many years in both a solid and liquid phase for reduced sulfur compound oxidation in many applications and industries.

The primary reaction product is potassium sulfate and is retained on the zeolite substrate for disposal. The reaction will not reverse in situ, and does not result in a hazardous waste. The zeolite used is a very high grade, low clay substrate that offers high hardness and an extremely high reaction site surface area. The media is easy to handle, can be land filled when spent, and will not support combustion.

The ACC deep bed scrubber design allows for bulk media loading and vacuum unloading through a top access door. A typical media changeout can be accomplished in little more than one hour.

Stage 4 – Central Exhaust Fan

A central exhaust fan maintains a constant exhaust volume and ensures that all system components operate under negative air pressure reducing the opportunity for fugitive vapor leaks. The fan capacity is approximately 6,500 cfm.

The central exhaust fan is an industrial radial centrifugal pressure blower. The blower is arrangement 4, direct driven. The fan is constructed in accordance with our corrosive gas service specification that includes for features such as all 304L SS airstream components, continuous welds on the housing and a formed EPDM gasket on the inlet plate. The fan housing is complete with a condensate drain and access port.

Stage 5 – Discharge Stack
The final stage is an atmospheric dispersion stack designed to adequately disperse residual reduced sulfur compounds as well as gas phase hydrocarbons that are not removed by the scrubber.

Bowker & Associates reviewed the design basis of the proposed odor control system and discussed it with both Global's engineering consultant, M. J. Bradley & Associates as well as the system vendor, Applied Contaminant Control.

In the judgment of Bowker & Associates, the system as proposed will likely result in a significant reduction in odor emissions from the Global facility. However, there are still concerns regarding the magnitude of the overall odor reduction and how the reduction will be perceived by local residents. Such concerns include the following:

1. The system will only capture emissions from the No. 6 and No. 4 tank vents and truck loading racks. While this is expected to reduce overall emissions by up to 75 percent, significant potential remains for residents living near the truck rack to be affected by odor emissions during loading of home heating oil (No. 2).
2. Although the proposed system is considered to be Best Available Control Technology for this application, and such systems have been successfully used in similar applications, no data exist to document the effectiveness in reducing odors (i.e. odor removal efficiency).
3. The system is claimed to reduce more than 95 percent of the hydrogen sulfide. However, H_2S is only one component of the odor. It is possible that the system could exhibit a high H_2S removal efficiency but a relatively poor odor removal efficiency.
4. The vendor has suggested that the media will last one year before replacement is necessary. Replacement frequency must be based on monitoring of the system outlet for reduced sulfur compounds, not on theoretical predictions for breakthrough of odors.

It is recommended that the City move forward with the odor control system for the No. 6 oil, but reserve the right to require additional controls should odors from the remainder of the truck loading rack cause complaints from abutting residents.

5.2 Boston Hides & Furs

The current method of applying "odor neutralizing agents" along the fence behind Boston Hides & Furs is likely to be only marginally effective in reducing the levels of odors in the area surrounding the facility. Unfortunately, due to the large number of hides stored in the building and the large volume of odorous air in the sorting, storage, and loading areas, controlling these odor emissions becomes a challenge.

The possible odor mitigation alternatives are as follows:

1. Capture and treat odorous air. This alternative would involve the following elements:
    a. Installation of an exhaust ventilation system to capture the air from all odorous areas, including the receiving area, the processing area, the storage area, and the loading area. Sufficient air would be drawn from each area to maintain a slight negative pressure, preventing the escape of odors. Total air flowrate would likely be in the range of 10,000 to 20,000 cubic feet per minute (cfm).
    b. Treatment of the odorous air using activated carbon or other treatment technology. The air captured from the odorous processing and storage areas would be directed through an activated carbon adsorber to remove the odorous constituents prior to discharge.

    The capture and treat alternative would likely reduce odor emissions by up to 90 percent if all the odorous air were to be captured. This would be difficult when the bay doors are open during loading and unloading.

2. Relocate odor neutralizing sprays. This alternative would involve relocating the odorous air sprays to maximize the contact between the odorous compounds and the "neutralizing agent."

    There are five major openings to the building where odors can escape: two adjacent bay doors at the Marginal St. loading dock where hides are unloaded, two side loading docks on Charles Street where the sorted and trimmed hides are loaded onto trucks, and another bay door that accesses the Charles St. loading area that is used to bring salt into the

building. At operations such as solid waste transfer stations, odor counteractants are sometimes applied around the perimeter of open bay doors where odors can escape. This increases the potential for contact of the counteractant with the odorant. The counteractant sprays can be set up to apply product only when the door is opened. Waterless systems are also available that apply a counteractant vapor that is not subject to freezing and which can be applied year round. In the experience of Bowker & Associates, a 20 to 40 percent reduction in odor strength can be expected.

3. Inventory Management and Housekeeping. The fewer the hides stored on-site, the less odor to be emitted. At any given time, there may be 100,000 hides awaiting sorting, being processed, or awaiting shipping. If it were possible to reduce the inventory of hides, odor emissions may be reduced proportionally. According to Boston Hides & Furs, while reducing the inventory would be desirable, it is unlikely to be practical given the large fluctuation in the frequency of deliveries.

   With regard to housekeeping practices, interior floors and the floors of trucks are washed down daily with hot water, and a pine-scented cleaning product is applied to outside loading areas every few days during the summer. Although the hot water wash is helpful to remove odorous residual material, the surfaces themselves probably retain the odor. Use of a mild bleach solution or other oxidant is likely to be more effective in mitigating any residual odor on the concrete floors in the building and the floors of the truck trailers. It may be necessary to experiment with various products in order to find one that is effective but which has no potential to damage or impart an odor to the hides.

   It is recommended that:

   - the odor counteractant be applied along the perimeter of all three loading doors whenever the doors are open.
   - a mild bleach solution be used to wash down floors and walls of the hide storage and processing areas as well as the truck trailers on a daily basis.
   - the inventory of hides stored at the facility be maintained at the lowest possible level in order to minimize the intensity of the odor from the facility

5.3 MWRA Facilities

The local wastewater screening/pumping facility and the Chelsea Headworks, both located at the corner of Marginal Street and the Chelsea St. Bridge, are equipped with odor control systems. Provided they are properly maintained, the odor control systems should adequately control odor emissions from the two buildings in which wastewater is processed. However, odors continue to be emitted from the junction chamber located along the fence adjacent to Marginal Street. The sewage odors are often detectable from Marginal Street. Attempts have been made to contain/treat the odors, but these have apparently been unsuccessful.

Another potential source of odor from the MWRA facilities is the grit and screenings containers stored outside the Chelsea Headworks. Although originally designed to accommodate flexible ducts to extract the air to the central odor control system, the ducts are no longer used and may not be functional. According to MWRA staff, a design is underway to completely enclose the containers in a building, and evacuate the air to an odor control system.

MWRA utilizes the services of an odor and corrosion control consultant that has been involved in several odor control projects at MWRA facilities. It is recommended that MWRA utilize his services to conduct the following:

1. Characterization of the junction chamber emissions with regard to hydrogen sulfide and odor
2. Measurement of air emission rate and calculation of the air extraction rate necessary to prevent escape of odors
3. Design of a suitable odor control technology such as a biofilter, or expansion of existing odor control systems to accommodate the new source.

5.4 Chelsea Sewer System

The storm sewer along Marginal Street is clearly a source of odor when it floods during heavy rains. Residents and City staff have reported a strong sewage odor during such events. Although the presence of a combined sewer (sanitary sewage plus storm water) would explain the sewage odor when the sewer floods, the City verified that separate sanitary and storm sewers exist along Marginal Street. Unless there are illegal connections, the flooding should consist of only storm water. The flooding is apparently due to blockage of an old combined sewer overflow structure when it was inadvertently filled with concrete. An engineering firm has been hired by the City to design a new stormwater outfall structure. Given that the existing outfall is partially blocked, the storm sewer is always partially filled with water. It is likely that there is a substantial amount of decomposing organic deposits that never get completely flushed out of the sewer. During rain events, the sediments become agitated, releasing odorous gases such as hydrogen sulfide that is a major odorant in sewer gas. Once the new stormwater outfall is placed into service, the storm sewer should be thoroughly cleaned to remove sediments that have accumulated over many years. Construction of a new outfall is expected to begin in 2006.

Another area of concern is the Arlington Street sewer system near the border with Everett. According to the City, there are some sanitary connections into the existing storm sewer that are being investigated. Some sanitary sewers that previously conveyed combined sanitary sewage and stormwater are now oversized, causing low sewage velocities, deposition of organic material, and generation of odors. Little information is available on storm sewers from Everett that discharge into the Island End River, as they are shown on drawings as "private" sewers. In addition, there are problems with the vertical alignment of the Carter St. sewer that causes sewage to pond, creating stagnant conditions that foster the formation of hydrogen sulfide.

It is recommended that the City conduct an evaluation of the sanitary and storm sewers with regard to odor emission potential. This would involve installation of datalogging H_2S analyzers at critical locations, sampling of the wastewater streams for sulfide and other parameters, and evaluating physical factors such as slope, sewage velocities, solids deposition, inverted siphons, etc.

5.5 Miscellaneous Chelsea Sources

There are other potential sources of odor along the Chelsea waterfront, for some of which no control strategy can be offered. For example, during low tide, exposed sediments along Chelsea Creek and the Island End River can release odors that include hydrogen sulfide. Salt marshes can be a major source of this odorant.

The General Mills/Pillsbury bakery at the foot of Admiral's Hill near the Island End River, is a source of "baking" odors that are generally regarded as pleasant. However, due to concerns with odor emissions, the company is considering implementing odor mitigation measures.

Another minor source of odor previously identified was the refuse containers at the base of Winnisimmet Street. Rotten fish odors were due to the disposal of dead lobsters. Apparently, the dead lobsters are now frozen and placed in sealed bags.

Diesel trucks operate throughout Chelsea due to the large industrial base in Chelsea, Everett, Revere, and East Boston. Trucks are no longer permitted to idle when loading fuel oil at the Global facility. Little can be done to avoid the odors from diesel truck exhausts other than divert truck traffic around residential areas.

5.6 Non-Chelsea Sources

The City of Everett has a large number of industries that are potential sources of odors. These include the large produce warehouses, an asphalt batching plant, an LNG storage facility and power plant, and others. Many of these industries are located close to the border with Chelsea. In addition, the sewer system of Everett may be a potential source of odors.

Although odor sources in Everett are beyond the scope of this project, it is possible, if not likely, that some odors that originate in Everett are detected by residents in Chelsea. It is recommended that representatives of both Cities meet to discuss this issue. The City of Chelsea should request

a list of industries in Everett, and meet with the City of Everett to discuss which of those industries have the potential to emit odors. This can help the City of Chelsea to find the source of odors when complaints are received and the wind is blowing from the west toward Chelsea.

5.7 Summary of Recommendations

Table 5 summarizes the recommended strategies for mitigating odors from the potential sources or further evaluating their contribution to elevated ambient odor levels in the community.

TABLE 5

SUMMARY OF RECOMMENDED ODOR MITIGATION STRATEGIES

Odor Source and Location	Type of Odor	Recommended Odor Mitigation Strategy
1. Global Oil Terminal 11 Broadway, Chelsea	Petroleum, sulfur	1. Install capture/treat system for No. 6 and No. 4 tanks and truck racks; measure performance. 2. Continue to monitor and follow-up on complaints from residential areas downwind.
2. Boston Hides & Furs 150 Marginal St, Chelsea	Dead animal	1. Relocate/add odor neutralizer sprays to all open bay doors; activate when doors are open. 2. Wash down floors and trucks with bleach daily. 3. Reduce inventory of hides.
3. MWRA Facilities Marginal St at Chelsea Bridge	Sewage, rotten egg	1. Design and construct system to capture and treat emissions from junction box. 2. Conduct annual testing of all odor control systems
4. Chelsea sewer system, Marginal St, Arlington St, others?	Sewage, rotten egg	1. Construct new outfall for Marginal St storm sewer 2. Inventory sewers with regard to odor potential
5. Miscellaneous, City of Everett	Petroleum, rotten egg, others?	1. Meet with City of Everett to identify potential sources 2. Conduct odor surveys to verify major sources. 3. Encourage City of Everett to develop odor mitigation plan.

6. DEVELOPMENT OF CITY-WIDE ODOR ORDINANCE

The City of Chelsea has many industries and commercial establishments that emit odors, but no laws specifically address the control of odors on a City-wide basis. Very few states have laws that regulate odors other than general "nuisance" laws. Some states, like Colorado and Connecticut, have specific language in their laws that limit the level of odor at the property fenceline as measured using a portable olfactometer or by comparison to standard reference odors. Others use concentrations of specific odorants such as hydrogen sulfide in the ambient air. There are no federal regulations governing odor emissions.

Particularly where multiple sources of odor exist, some communities have developed their own ordinances to regulate odors. There are many criteria that can be used, often in combination, to define compliance with the ordinance. These include (3):

1. Annoyance criteria (subjective categories)
2. Compliant criteria (numbers of complaints)
3. Ambient odor detection threshold criteria (dilutions to threshold)
4. Ambient odor intensity criteria (0–5 or 0–8 butanol scale)
5. Ambient odorant criteria (e.g., ppb of H_2S)
6. Episode duration-frequency criteria (e.g., odor-hours)
7. Source emission criteria (e.g., pounds per day of odorant)
8. Technology-based criteria (e.g., best available control technology)

Massachusetts DEP has established a protocol for determining nuisance odor conditions (4). The protocol uses a five-point odor intensity referencing scale to conduct field evaluations in response to odor complaints. This is based on an ASTM procedure using n-butanol as the standard odorant. The scale is as follows (4):

0	Odor not detectable
1 – Very Light	Odorant present in the air which activates the sense of smell but the characteristics may not be distinguishable.

2 – Light	Odorant present in the air which activates the sense of smell and is distinguishable and definite but not necessarily objectionable in short durations but may be objectionable in longer durations.
3 – Moderate	Odorant present in the air which easily activates the sense of smell, is very distinct and clearly distinguishable and may tend to be objectionable and/or irritating.
4 – Strong	Odorant present in the air which would be objectionable and cause a person to attempt to avoid it completely.
5 – Very Strong	Odorant present which is so strong it is overpowering and intolerable for any length of time.

In general, an odor nuisance shall have been deemed to occur if the investigator determines that one of the following conditions exist.

1. The odor characteristic (or type of odor, separate from the intensity of the odor, example: rotten egg type of garbage odor) is deemed to unpleasant or objectionable and the odor intensity is rated as level four (4) or greater for any period of time.
2. The odor characteristic (or type of odor, separate from the intensity of the odor, example: rotten egg type of garbage odor) is deemed to be unpleasant or objectionable and the average odor intensity of the odor as determined by the inspector to constitute a level three (3) or greater for a period of 15 minutes or greater. Odor "observations" shall be made at least twice during the 15 minute period and shall be noted in a log book or form to be developed by DEP.
3. The odor characteristic (or type of odor, separate from the intensity of the odor, example: rotten egg type of garbage odor) is deemed to be unpleasant or objectionable and the odor intensity is determined by the inspector to constitute a level of two (2) or between levels two (2) and three (3) for a period of 60 minutes of greater. Odor "observations" shall be made at least three (3) times during the 60 minute period. DEP recognizes that the investigator will want to be able to continue with the odor survey. Therefore, the investigator may leave the area in question as long as the investigator is present at the beginning and approximately the end of the 60 minute period and also is present during some portion of the time in between. DEP may also consider the number of complaints received and the reported duration of the odor event when considering whether a "Level Two" odor would constitute a nuisance.
4. Other conditions that in the opinion of the DEP constitutes nuisance conditions, based on the frequency, intensity, and duration of odors.

Developing a municipal odor regulation requires careful review of all existing local, sate, and national law that may limit components of a regulation. A recommended format for such regulations is as follows (3):

1. Purpose Statement
2. Authority Source
3. Definitions
4. Jurisdiction
5. Complaint Verification
6. Standards and Limits (Compliance Criteria)
7. Notices of Violations
8. Penalties
9. Remedies
10. Appeals
11. Permitting
12. Exclusions
13. Modeling
14. Limitations

The development of an odor ordinance or regulation requires a certain scientific and administration infrastructure to be developed. Important elements of such an infrastructure may include:

1. Odor complaint "hot line"
2. Trained odor inspectors
3. Procedures for odor complaint review
4. Odor testing
5. Odorant measurement
6. Odor modeling
7. Procedure for Odor Prevention and Review of Odor Control Technology

The City of Chelsea has been provided with a copy of the paper "Elements of Successful Odor Laws" that is referenced in this section. Discussions with the principal author of this paper

resulted in contacts with Des Moines, Iowa, a city that has implemented a successful odor regulation. A copy of this regulation, as well as one from the City of Portland, Maine was forwarded to the Chelsea Board of Health.

Given the large number of odor sources in and around Chelsea, it is recommended that the City establish an odor "hot-line" and strongly consider developing its own odor ordinance. In addition to developing a comprehensive, enforceable ordinance, this would require training of odor inspectors to respond to odor complaints and to document odor conditions, identify the source(s) of odor, etc. The City of Des Moines formed an odor advisory committee that meets quarterly to review odor complaints, assess progress by industries to control odor emissions, and recommend action against industries judged to be significant sources of odor.

REFERENCES

1. Letter report from Goldman Environmental Consultants to City of Chelsea, Re: "Proposed Odor Abatement at the Chelsea Terminal," Nov. 23, 1998.

2. Excerpts of May 31, 2004 proposal from Applied Contaminant Control to Global Petroleum Corporation.

3. McGinley, C.M., T.D. Mahin, and R.J. Pope, "Elements of Successful Odor/Odour Laws," Odor and VOC Emissions 2000, Water Environment Federation, Alexandria, VA, 2000.

4. Mahin, Tom, "Using Odor Intensity Rating During Complaint Investigations to Determine Whether Nuisance Odor Conditions Exist," Proceedings of WEFTEC 2000, Water Environment Federation, Alexandria, VA, 2000.